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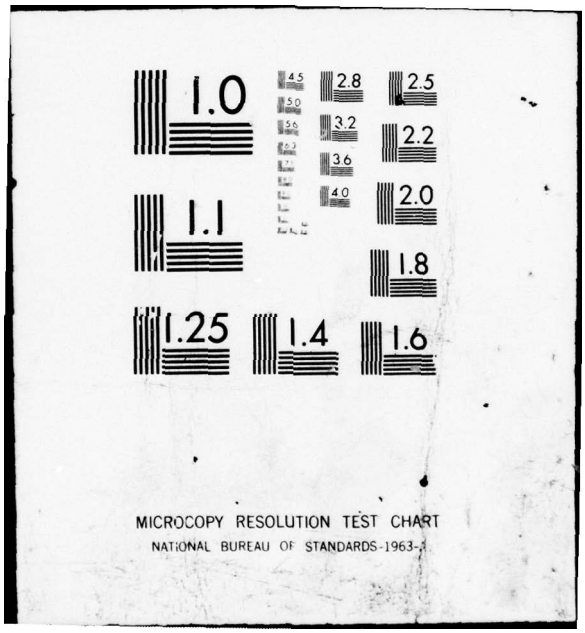
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UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010

PESTICIDE MONITORING ANNUAL REPORT NO. 17-44-0140-79
DEPARTMENT OF THE ARMY PESTICIDE MONITORING PROGRAM
EVALUATION OF ENVIRONMENTAL SAMPLES
COLLECTED IN CALENDAR YEAR 1976

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REPORT DOCUMENTATION PAGE

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Pesticides	Fish	Pesticide Management
Monitoring	Birds	
Environment	Residues	
Soil	Analysis	
Sediment	Statistical Analysis	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Results of the calendar year 1976 Department of the Army Pesticide Monitoring Program are presented. Significant findings and conclusions are as follows:

a. Untransformed data should not be relied upon in making statistical comparisons of environmental pesticide residues.

b. The stratified sampling design is adequate to provide an environmental pesticide profile of an installation.

c. Significant differences observed in CY 75 soil data were again evident in CY 76 data. → over

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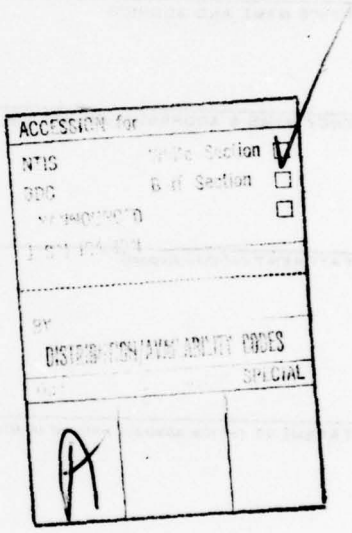
d. Significant differences observed in CY 75 sediment data were not observed in CY 76 data.

e. Fish exhibit a greater diversity of pesticide residues than corresponding sediment.

f. Statistically significant interactions among the various components were noted with regard to quantitative data.

g. Two years data did not indicate any significant general trends or patterns in pesticide residues.



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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

Mr. Olds/pj/584-3613

26 MAR 1979

HSE-RP/WP

SUBJECT: Pesticide Monitoring Annual Report No. 17-44-140-79, Department of the Army Pesticide Monitoring Program, Evaluation of Environmental Samples Collected in CY 76

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Results of the calendar year 1976 Department of the Army Pesticide Monitoring Program are presented in the inclosed report. Significant findings and conclusions are as follows:

a. Untransformed data should not be relied upon in making statistical comparisons of environmental pesticide residues. The stratified sampling design is adequate to provide an environmental pesticide profile of an installation. Significant differences observed in CY 75 soil data were again evident in CY 76 data. Significant differences observed in CY 75 sediment data were not observed in CY 76 data. Fish exhibit a greater diversity of pesticide residues than corresponding sediment. Statistically significant interactions among the various components were noted with regard to quantitative data. Two years data did not indicate any significant general trends or patterns in pesticide residues.

b. Recommendation is made to:

(1) Sample only soil and sediment from scheduled installations to provide confirmation of relationship among these components.

(2) Use best available methodology to expend the qualitative range of pesticides detectable.

(3) Issue only a consolidated report on combined installation data pending establishment of environmental baseline data.

FOR THE COMMANDER:

Frank E McDermott

FRANK E. McDERMOTT
LTC(P), MSC
Director, Radiation and
Environmental Sciences

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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

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PESTICIDE MONITORING ANNUAL REPORT NO. 17-44-0140-79
DEPARTMENT OF THE ARMY PESTICIDE MONITORING PROGRAM
EVALUATION OF ENVIRONMENTAL SAMPLES
COLLECTED IN CALENDAR YEAR 1976

1. AUTHORITY.

a. AR 40-5, Health and Environment, 25 September 1974.

b. AR 200-1, Environmental Protection and Enhancement, 20 January 1978.

c. Public Law 92-516, Federal Environmental Pesticide Control Act of 1972, 21 October 1972, as amended by PL 95-396, 30 September 1978.

2. REFERENCES.

a. USAEHA Pesticide Monitoring Annual Report No. 44-0100-78, Department of the Army Pesticide Monitoring Program Evaluation of Environmental Samples Collected in Calendar Year 1975, ADA050880.

b. USAEHA Pesticide Monitoring Special Study No. 44-111-76, Pesticide Monitoring Guidelines, Scheduled Monitoring (effective 1 April 1976), ADA029983.

3. PURPOSE. To provide additional data for the establishment of an integrated data base for the Department of the Army Pesticide Monitoring Program (DAPMP). To evaluate the calendar year 1976 (CY 76) data with the calendar year 1975 (CY 75) data for possible trends and patterns.

4. BACKGROUND.

a. Many of the problems noted in reference 2a regarding sample collection, shipment and storage were not resolved for the 1976 samples. As a result, the sample integrity concerning nonpersistent pesticides (organophosphate pesticide residues) is questionable.

b. Efforts to reduce the analysis time of the CY 76 samples allowed the analysis of samples from only 14 installations. This reduction also limited the analysis of DDT residues to selected samples. The DDT analysis included all samples from four installations plus all pesticide shop and storage soil samples. All samples which were analyzed for DDT were also analyzed for polychlorinated biphenyls (PCB's). These PCB's are of current major environmental concern and, as such, require the establishment of some baseline data.

c. The analytical methodology and statistical evaluations used are the same as those reported in reference 2a. For statistical comparisons, a level of significance of $p<0.05$ has been adopted for this report. However, those differences which are highly significant ($p<0.01$) are reported as such.

d. Because of the limited number of samples for which DDT was analyzed, the predominance of data reported will ignore the DDT residues.

e. In addition to the discussion and evaluation of the CY 76 samples, an effort is made to compare CY 75 and CY 76 data for possible patterns or correlations and to determine if any trends are evidenced in 2 years data.

5. RESULTS AND DISCUSSION. The installations sampled in CY 76 are listed in Appendix A. The pesticides/pesticide metabolites analyzed for and the analytical detection limits for these pesticides/pesticide metabolites appear in Appendix B. The data for each environmental component are presented and discussed individually before the evaluation of possible relationships is discussed. The zonal stratifications used in the CY 75 report were shown to have little or no significance and are disregarded in this report.

a. Soil. The three major soil stratifications used with the CY 75 data were shown to be significantly different. These same groups were maintained for the CY 76 collection and analysis. An overall contrast of soil data appears in Table 1 and Table 2. The data in Table 1 reflect an overall contrast of untransformed means derived by excluding the DDT (and PCB) residues in all samples. The data in Table 2 reflect an overall contrast of untransformed means from those soil samples for which DDT (and PCB) was analyzed. The data in Table 2 are, in actuality, a subset of the data in Table 1.

(1) Soil Group I consists of pesticide shop, storage and disposal areas along with landfill areas and sewage treatment/disposal areas.

(2) Soil Group II consists of residential, cantonment, recreation and golf course areas. A comparison using untransformed means of the golf course subset with the other Group II areas (excluding DDT) is given in Table 3.

(3) Data from Soil Group III are comprised of outleased lands and range and training areas.

(4) Transformed data, as described in reference 2a, were used to evaluate the various soil stratifications.

(a) The three soil groups based on land use were found to have a significant difference ($p<0.01$) using the transformed means for the sum of all pesticides (excluding DDT). See Table 4.

(b) Using the transformed means for the sum of all pesticides (excluding DDT), the golf courses exhibit a significantly higher pesticide concentration than the other areas in Soil Group II (Table 5). This substantiates the hypothesis that golf courses have a significantly higher pesticide burden than other recreational or high occupancy areas.

TABLE 1. PESTICIDE RESIDUES (ppm) DETECTED IN SOIL SAMPLES COLLECTED DURING CALENDAR YEAR 1976, UNTRANSFORMED DATA (WITHOUT DDT)

	GROUP I			GROUP II			GROUP III			CONSOLIDATED		
No. of Samples	37			159			76			272		
Pesticides	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max
methoxychlor	0.74	5	15.42	0.02	3	2.89	nd	--		0.12	2	15.42
oxychlordane	nd	-		<0.01	3	0.07	nd	--		<0.01	1	0.07
aldrin	0.08	8	2.32	<0.01	1	0.81	nd	--		0.01	2	2.32
chlordane	413.60	54	11085.00	0.23	14	7.20	<0.01	1	0.14	56.40	16	11085.00
dieldrin	1.67	49	20.28	0.43	32	25.95	<0.01	1	0.02	0.48	26	25.95
endrin	0.06	11	1.28	<0.01	5	0.25	nd	--		0.01	4	1.28
heptachlor	nd	--		<0.01	<1	<0.01	nd	--		<0.01	<1	<0.01
heptachlor epoxide	<0.01	5	0.05	0.01	8	0.78	nd	--		<0.01	5	0.78
toxaphene	nd	--		0.01	<1	2.32	nd	--		0.01	<1	2.32
trans-chlordane	0.01	14	0.21	0.01	16	0.20	nd	--		0.01	11	0.21
cis-chlordane	nd	--		<0.01	4	0.59	nd	--		<0.01	3	0.59
lindane	0.11	14	1.86	nd	--		nd	--		0.02	2	1.86
malathion	0.10	14	1.96	nd	--		nd	--		0.01	2	1.96
chlorpyrifos	0.03	11	0.66	nd	--		nd	--		<0.01	1	0.66
diazinon	0.22	19	6.35	nd	--		nd	--		0.03	3	6.35
mirex	nd	--		nd	--		nd	--		nd	--	
parathion	nd	--		nd	--		nd	--		nd	--	
ronnel	<0.01	3	0.03	nd	--		nd	--		<0.01	<1	0.03
No. of Compounds	12			11			2			16		
Equivalent Pounds per acre	416.63			0.77			<0.01			57.10		

nd = No pesticides detected.

TABLE 2. PESTICIDE RESIDUES (ppm) DETECTED IN SOIL SAMPLES COLLECTED DURING CALENDAR YEAR 1976, UNTRANSFORMED DATA (WITH DDT)

	GROUP I			GROUP II			GROUP III			CONSOLIDATED		
No. of Samples	27			41			20			88		
Pesticides	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max
methoxychlor	1.01	7	15.42	0.09	10	2.89	--		--	0.35	7	15.42
oxychlordane	--	--	--	--	--	--	--		--	--		--
aldrin	0.11	11	2.32	0.02	2	0.81	--		--	0.04	5	2.32
chlordane	566.79	74	11085.00	0.34	17	7.20	--		--	174.06	31	11085.00
dieldrin	2.28	56	20.28	1.15	73	25.95	<0.01	5	0.02	1.24	52	25.95
endrin	0.09	15	1.28	0.02	15	0.25	--		--	0.04	11	1.28
heptachlor	--	--	--	--	--	--	--		--	--		--
heptachlor epoxide	<0.01	4	0.01	<0.01	7	0.02	--		--	<0.01	5	0.02
toxaphene	--	--	--	0.06	2	2.32	--		--	0.03	1	2.32
trans-chlordane	0.01	7	0.21	0.01	17	0.14	--		--	0.01	10	0.21
cis-chlordane	--	--	--	<0.01	5	0.13	--		--	<0.01	2	0.13
lindane	0.16	19	1.86	--		--	--		--	0.05	6	1.86
malathion	0.14	41	1.96	--		--	--		--	0.04	13	1.96
chlorpyrifos	0.04	15	0.66	--		--	--		--	0.01	5	0.66
diazinon	0.30	30	6.35	--		--	--		--	0.09	9	6.35
mirex	--		--	--		--	--		--	--		--
parathion	--		--	--		--	--		--	--		--
Aroclor 1248®	--		--	--		--	--		--	--		--
Aroclor 1242®	--		--	--		--	--		--	--		--
Aroclor 1254®	--		--	0.11	2	4.68	--		--	0.05	1	4.68
Aroclor 1260®	--		--	--		--	--		--	--		--
ronnel	<0.01	4	0.03	--		--	--		--	<0.01	1	0.03
o,p'-DDD	0.23	41	2.53	0.03	10	0.68	--		--	0.08	17	2.53
p,p'-DDD	6.57	48	155.59	0.10	22	1.53	--		--	2.06	25	155.59
o,p'-DDE	0.05	4	1.32	<0.01	7	0.09	--		--	0.02	5	1.32
p,p-DDE	0.78	56	7.41	0.57	71	4.89	--		--	0.50	50	7.41
o,p'-DDT	1.03	56	12.49	0.20	41	3.87	--		--	0.41	37	12.49
p,p'-DDT	14.89	63	224.61	1.38	61	17.09	--		--	5.21	48	224.61
No. of Compounds	18			16			1			21		
Equivalent pounds per acre	594.47			4.09			<0.01			184.30		

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TABLE 3. PESTICIDE RESIDUE DATA (ppm) FOR GOLF COURSE SOILS CONTRASTED WITH THE OTHER AREAS IN SOIL GROUP II, UNTRANSFORMED DATA (WITHOUT DDT)

	GROUP II minus Golf Course*			Golf Course		
No. of Samples	126			33		
Pesticides	$\bar{x}$	% Pos	Max	$\bar{x}$	% Pos	Max
methoxychlor	0.03	3	2.89	--		--
oxychlordane	<0.01	2	0.07	<0.01	6	0.01
aldrin	0.01	2	0.81	--		--
chlordane	0.26	13	7.20	0.15	15	2.54
dieldrin	0.41	34	25.95	0.51	24	12.55
endrin	<0.01	5	0.25	<0.01	6	0.13
heptachlor	<0.01	1	0.007	--		--
heptachlor epoxide	<0.01	4	0.78	<0.01	21	0.07
toxaphene	--		--	0.07	3	2.32
trans-chlordane	<0.01	10	0.15	0.03	42	0.20
cis-chlordane	0.01	4	0.59	<0.01	6	0.08

* Includes β-BHC at 0.18 ppm maximum concentration.

TABLE 4. STATISTICAL COMPARISON OF TRANSFORMED MEAN PESTICIDE RESIDUE DATA (ppm) BY SOIL GROUPS (WITHOUT DDT)

No. of Samples	Group I 37	Group II 159	Group III 76	Group I	Group II	Group III
				s*	s*	
				s*		
Minimum	0	0	0			
Mean	2.18	0.75	0.02			
Maximum	6.04	3.47	1.18	ℓsd (p<0.05)=0.252		
Standard Deviation	1.68	0.91	0.14	ℓsd (p<0.01)=0.327		

* s indicates significant lsd difference.

TABLE 5. STATISTICAL COMPARISON OF TRANSFORMED MEAN PESTICIDE RESIDUES (ppm) COMPARING GOLF COURSES AND SOIL GROUP II MINUS GOLF COURSES (WITHOUT DDT)

	Golf Courses	GROUP II minus Golf Courses	Golf Courses	GROUP II minus Golf Courses
No. of Samples	33	126		
			s*	
Minimum	0	0		
Mean	0.90	0.71		
Maximum	3.10	3.47	ℓsd ($p<0.05$)=0.17	
Standard Deviation	0.89	0.93		

* s indicates significant lsd value.

b. Sediment. These data are tabulated and evaluated on the basis of four functional sampling stratifications; traversing streams at their entrance to the installations, traversing streams at their exits, streams originating on the installation and impounded bodies of water. Only 19 of the sediment samples were analyzed for DDT (and PCB) residues. The data from these analyses yielded little useful information and consequently DDT (and PCB) sediment data are excluded from this report.

(1) The overall CY 76 untransformed mean data for the four functional sediment stratifications are presented in Table 6.

(2) With the DDT data excluded, the total mean concentration for soil is approximately 570 times higher than that for sediment (57.10 ppm versus 0.01 ppm). The number of compounds (excluding DDT) found in the soil is approximately three times that found in the sediment (16 for soil and 5 for sediment).

(3) Statistical evaluation of pesticide residues found in sediment using transformed means reveals no significant differences among the four sampling stratifications (Table 7).

c. Fish. Statistical analysis of the data on fish collected in CY 75 revealed little or no significant difference between top and bottom feeding stratifications. Therefore, only bottom feeding fish were analyzed for CY 76. There were only 35 fish samples from 10 installations available. This was due, in part, to the inability to collect the desired species and to an accidental defrost incident in the laboratory. Only four of the fish samples were analyzed for DDT (and PCB) residues. As in the case of the sediment, these data provided little useful information and consequently are excluded from this report.

(1) The fish data are stratified according to those fish collected from streams and those collected from impounded bodies of water. The untransformed mean data for CY 76 fish samples are presented in Table 8. The data in Table 8 seems to indicate that the major contamination of fish occurs in impounded bodies of water.

(2) Statistical evaluation of the fish data, however, does not corroborate the instinctive conclusions derived from the raw data. The analysis of variance comparing transformed means shows no significant difference between fish collected from streams and fish collected from impounded bodies of water (Table 9).

d. Birds. There were only six bird samples available for analysis. This limited amount of data does not allow statistical comparisons; however, the untransformed data do permit some observations regarding this component.

(1) Only five pesticides/pesticide metabolites (excluding DDT) were detected in birds (see Table 10).

TABLE 6. PESTICIDE RESIDUES (ppm) FROM VARIOUS CALENDAR YEAR 1976 SEDIMENT COLLECTION SITES, UNTRANSFORMED DATA

	All Sites		Traversing/ Entrance		Traversing/ Exit		Originating		Impounded	
No. of Samples	122		17		19		12		74	
Pesticides	$\bar{x}$	Max	$\bar{x}$	Max	$\bar{x}$	Max	$\bar{x}$	Max	$\bar{x}$	Max
aldrin	<0.01	0.47	--	--	--	--	--	--	0.01	0.47
chlordane	<0.01	0.12	--	--	--	--	0.01	0.12	<0.01	0.10
dieldrin	<0.01	0.07	--	--	--	--	--	--	<0.01	0.07
trans-chlordane	<0.01	0.02	<0.01	0.01	--	--	--	--	<0.01	0.02
cis-chlordane	<0.01	0.02	<0.01	0.01	--	--	--	--	<0.01	0.02
Total Concentration	0.01		<0.01		--		0.01		0.02	
No. of Pesticides	5		2		--		1		5	

TABLE 7. STATISTICAL EVALUATION OF PESTICIDE RESIDUES (ppm) IN SEDIMENT FROM VARIOUS COLLECTION LOCATIONS, TRANSFORMED DATA

	All Sediment	Traversing Entrance	Traversing Exit	Originating	Impounded
No. of Samples	122	17	19	12	74
Minimum	0	0	0	0	0
Mean	0.08	0.03	0	0.09	0.12
Maximum	1.74	0.48	0	1.11	1.74
Standard Deviation	0.29	0.12	0	0.32	0.34

$\ell sd\ (p<0.05)=0.12$

TABLE 8. PESTICIDE RESIDUES (ppm) DETECTED IN CALENDAR YEAR 1976 FISH SAMPLES, UNTRANSFORMED DATA

	All Fish		Fish From Streams		Fish From Impounded Bodies	
No. of Samples	35		9		26	
Pesticides	$\bar{x}$	Max	$\bar{x}$	Max	$\bar{x}$	Max
oxychlordane	<0.01	0.05			<0.01	0.05
aldrin	0.01	0.35			0.01	0.35
chlordane	0.03	0.63			0.04	0.63
dieldrin	0.14	2.53	<0.01	0.02	0.19	2.53
endrin	<0.01	0.11			<0.01	0.11
heptachlor epoxide	<0.01	0.08	<0.01	0.009	<0.01	0.08
toxaphene	0.01	0.46			0.02	0.46
trans-chlordane	0.02	0.26	0.02	0.10	0.02	0.26
cis-chlordane	<0.01	0.03			<0.01	0.03
α-BHC	<0.01	0.006			<0.01	0.006
β-BHC	<0.01	0.27			0.01	0.27
diazinon	<0.01	0.17	<0.01	0.006	<0.01	0.17
mirex	<0.01	0.03			<0.01	0.03
Pesticides Detected	13		4		13	
Total Concentration	0.24		0.02		0.32	

TABLE 9. COMPARISONS OF THE TRANSFORMED MEAN PESTICIDE RESIDUE DATA (ppm) FOR FISH

	All Fish	Streams	Impounded
No. of Samples	35	9	26
Minimum	0	0	0
Mean	0.62	0.27	0.74
Maximum	2.62	1.14	2.62
Standard Deviation	0.79	0.43	0.86

TABLE 10. PESTICIDE RESIDUES (ppm) IN BIRD SAMPLES COLLECTED IN CALENDAR YEAR 1976, UNTRANSFORMED DATA (WITHOUT DDT)

No. of Samples	6	
Pesticides	$\bar{x}$	Max
oxychlordane	0.06	0.24
dieldrin	0.25	0.96
heptachlor epoxide	0.10	0.55
trans-chlordane	0.01	0.04
mirex	0.05	0.30

(2) The occurrence of mirex is from an installation on which mirex has been used.

(3) In evaluating the two bird samples analyzed for DDT (and PCB) residues (Table 11), it is interesting to note that, in addition to DDE residues being present, DDD was also present.

(4) The data reveal rather rapid pesticide metabolism in the birds, especially oxidative metabolism, as evidenced by the absence or the presence of only very low residues of parent pesticides.

e. Interactions Between Environmental Components. A convenient means of evaluating interaction is to evaluate data pairs; i.e., fish from a particular installation/sediment from that installation, soil from a particular installation/sediment from that installation, etc., to calculate correlation coefficients, "r".

(1) Correlations (involving 10 data pairs) between CY 76 fish and sediment, calculated using transformed means, indicated a correlation coefficient of 0.96 which based on a Z score of 2.87, indicates significance at the $p<0.05$ level [$Z\ (p<0.05)= \pm 1.96$]. It appears from these data that a definite correlation exists between pesticide residues in fish and in sediment from the same bodies of water.

(2) Correlations (involving 13 data pairs) between CY 76 soil (excluding DDT) and sediment, utilizing transformed means, indicated significant correlation at the $p<0.05$ level ($r=0.98$, $Z=3.41$). These data indicate that those installations with higher pesticide residues in soil probably also contained higher pesticide residues in sediment and visa versa.

(3) Significant correlation (involving six data pairs) between CY 76 soil and birds (excluding DDT) was noted. The correlation coefficient and the Z score, calculated using transformed means, were 0.95 and 2.12, respectively. These data, although based on a small number of data pairs, suggest that a correlation exists between pesticide residues in birds from an installation and pesticide residues in soil from the same installation.

(4) In addition to the correlations described above, a significant correlation (involving 10 data pairs) was also noted between CY 76 soil (excluding DDT) and fish, as evidenced by a correlation coefficient of 0.99 and a Z score of 2.97 calculated using transformed means. Considering the significant correlations observed between sediment and fish and between soil and sediment, it is not surprising that a significant correlation was observed between soil and fish also.

TABLE 11. PESTICIDE RESIDUES (ppm) IN BIRD SAMPLES COLLECTED IN CALENDAR YEAR 1976 (WITH DDT)

No. of Samples Pesticides	$\bar{x}$	2 Max
p,p'-DDD	0.02	0.04
p,p'-DDE	1.22	2.09
oxychlordane	0.13	0.01
dieldrin	0.65	0.96
heptachlor epoxide	0.28	0.55
trans-chlordane	0.02	0.04
mirex	0.15	0.30
Aroclor 1248	0.02	0.04
Aroclor 1260	1.54	1.78

f. Comparison of CY 75 and CY 76 Data. A comparison of only 2 years data cannot reveal much in overall trends. However, some qualitative and quantitative statements can be made. Both transformed and untransformed data will be presented and will be noted as such. The data presented for both CY 75 and CY 76 will have the DDT (and PCB) data excluded. Table 12 presents an overall comparison of the four substrates by individual pesticides utilizing untransformed data. Each substrate is further evaluated in succeeding sections.

(1) Table 13 presents a contrast of CY 75 and CY 76 consolidated untransformed soil data. The equivalent pounds per acre value is approximately 3.5 times higher in CY 76 than in CY 75. This is primarily the result of the large mean increase in chlordane (15.99 ppm for CY 75 versus 56.4 ppm for CY 76).

(a) In an effort to determine whether this mean difference in soil residues between CY 75 and CY 76 is significant, it is first necessary to determine if those installations collected in CY 76 truly represent the larger data base collected in CY 75. This was done by comparing the CY 75 transformed data for those 13 installations sampled in both CY 75 and CY 76 with the 33 installation transformed data for CY 75. This comparison is presented in Table 14 for the three soil groups. The differences observed between the 13 and 33 installation data are not significant, thus showing that the reduction from 33 installations in CY 75 to 14 installations in CY 76 does not alter the conclusions drawn from the CY 75 data. A comparison of CY 75 and CY 76 transformed data for the three soil groups is presented in Table 15. This table compares the 14 installation transformed soil data from CY 76 with the 33 installation transformed soil data from CY 75. It also compares the 13 installations for CY 75 and CY 76. In both cases, the soil Group I data are significantly higher for CY 76 than for CY 75.

(b) A further evaluation of soil Group I is presented in Table 16 using the untransformed data for CY 75 and CY 76. These data are again higher for CY 76 and again is largely the result of a chlordane increase. Table 17 compares the pesticide shop and storage areas with the other areas in soil Group I using transformed mean data. These data reveal that the pesticide shop and storage areas are significantly ($p<0.05$ level) higher than other Group I areas. However, the differences observed between CY 75 and CY 76 for the areas compared in Table 17 are not significant.

(c) Untransformed data for soil Group II for CY 75 and CY 76 are presented in Table 18. These data show a slight decrease in the overall pesticide residues for CY 76 (1.16 lb/acre for CY 75 versus 0.76 lb/acre for CY 76). Table 19 presents a comparison between the golf course areas and other areas in soil Group II using transformed mean data. For both CY 75 and CY 76, the golf course area has significantly higher residues than the other Group II areas but there is no difference between the areas when compared by years.

TABLE 12. CONTRAST OF UNTRANSFORMED PESTICIDE DATA (ppm) FOR SAMPLES COLLECTED IN CY 75 and CY 76

	SOIL				SEDIMENT				FISH				BIRDS			
	$\bar{x}$		max		$\bar{x}$		max		$\bar{x}$		max		$\bar{x}$		max	
	75	76	75	76	75	76	75	76	75	76	75	76	75	76	75	76
No. of Samples	697	272			363	122			108	35			13	6		
chlordane	15.99	56.4	4979	11085	0.01	<0.01	1.62	0.12	0.01	<0.01	0.64	0.05	nd	nd	nd	nd
oxychlordane	<0.01	<0.01	0.10	0.07	<0.01	nd	0.06	nd	0.002	0.031	0.06	0.63	0.04	0.06	0.14	0.24
trans-chlordane	0.01	0.01	0.45	0.21	<0.01	<0.01	0.30	0.02	0.04	0.02	0.35	0.26	0.01	0.008	0.06	0.04
cis-chlordane	0.01	<0.01	1.41	0.59	0.01	<0.01	2.53	0.02	<0.01	<0.01	0.02	0.03	nd	nd	nd	nd
dieldrin	0.42	0.48	107	25.95	<0.01	<0.01	0.10	0.07	0.05	0.142	1.11	2.53	0.09	0.25	0.61	0.96
aldrin	0.05	0.01	34.4	2.32	<0.01	<0.01	0.06	0.47	<0.01	0.011	0.10	0.35	nd	nd	nd	nd
endrin	0.05	0.01	2.95	1.28	nd	nd	nd	nd	<0.01	<0.01	0.11	0.11	nd	nd	nd	nd
heptachlor	<0.01	<0.01	0.25	<0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
heptachlor epoxide	0.01	<0.01	1.64	0.78	nd	nd	nd	nd	0.01	<0.01	0.08	0.08	0.04	0.099	0.24	0.55
methoxychlor	0.15	0.12	89.9	15.42	nd	nd	nd	nd	0.01	nd	1.01	nd	nd	nd	nd	nd
toxaphene	0.03	0.01	21.5	2.32	nd	nd	nd	nd	0.05	0.013	1.52	0.46	nd	nd	nd	nd
mirex	<0.01	nd	0.05	nd	nd	nd	nd	nd	0.01	<0.01	0.17	0.03	0.09	nd	0.64	nd
α-BHC	<0.01	nd	0.02	nd	nd	nd	nd	nd	nd	<0.01	nd	0.006	nd	nd	nd	nd
β-BHC	0.01	nd	0.06	nd	nd	nd	nd	nd	nd	0.008	nd	0.27	nd	nd	nd	nd
lindane	<0.01	0.02	0.37	1.86	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
chlorpyrifos	0.07	<0.01	15.01	0.66	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
malathion	0.01	0.01	0.73	1.96	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
diazinon	0.02	0.03	9.72	6.35	nd	nd	nd	nd	nd	0.005	nd	0.17	nd	nd	nd	nd
ronnel	nd	<0.01	nd	0.03	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
parathion	<0.01	nd	0.09	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

nd = no pesticides detected.

TABLE 13. CONTRAST OF 75/76 UNTRANSFORMED CONSOLIDATED SOIL DATA (ppm) (75 - 697 samples; 76 - 272 samples)

Pesticides	$\bar{x}$		% Positive		max	
	75	76	75	76	75	76
methoxychlor	0.15	0.12	2	2	89.9	15.42
oxychlordane	<0.01	<0.01	2	1	0.10	0.07
aldrin	0.05	0.01	1	2	34.4	2.32
chlordane	15.99	56.4	21	16	4979	11085
dieldrin	0.42	0.48	23	26	107	29.95
endrin	<0.01	0.01	1	4	2.95	1.28
heptachlor	<0.01	<0.01	1	<1	0.25	<0.01
heptachlor epoxide	0.01	<0.01	6	5	1.64	0.78
toxaphene	0.03	0.01	1	<1	21.5	2.32
trans-chlordane	0.01	0.01	8	11	0.45	0.21
cis-chlordane	0.01	<0.01	4	3	1.41	0.59
lindane	<0.01	0.02	1	2	0.37	1.86
malathion	0.01	0.01	2	2	0.73	1.96
chlorpyrifos	0.07	<0.01	2	1	15.01	0.66
diazinon	0.02	0.03	2	3	9.72	6.35
mirex	<0.01	nd	1	--	0.05	nd
ronnel	nd	<0.01		<1	nd	0.03
parathion	<0.01	nd	1	--	0.09	nd
No. cpds	17	15				
lb/acre	16.68	57.16				

nd = no pesticides detected.

TABLE 14. COMPARISON OF TRANSFORMED MEAN SOIL DATA FOR 13 INSTALLATIONS FROM CY 75 VERSUS 33 INSTALLATIONS FROM CY 75 FOR THE THREE SOIL GROUPS

	SOIL GROUPS		
	I	II	II
13 Installations	1.65	0.80	0.02
33 Installations	1.68	0.78	0.10
	lsd ($p<0.05$) = 0.26		

TABLE 15. COMPARISON OF TRANSFORMED MEAN SOIL DATA FOR 13 INSTALLATIONS AND FOR ALL INSTALLATIONS FOR CY 75 AND CY 76 BY SOIL GROUPS

	SOIL GROUPS					
	I		II		III	
	CY 75	CY 76	CY 75	CY 76	CY 75	CY 76
13 Installations	1.65	2.27	0.80	0.78	0.02	0.02
All Installations	1.68	2.18	0.78	0.74	0.10	0.02
	lsd ($p<0.05$) = 0.20					

TABLE 16. CONTRAST OF 75/76 UNTRANSFORMED SOIL GROUP I DATA (ppm) (75 - 107 samples; 76 - 37 samples)

Pesticides	$\bar{x}$ 75	$\bar{x}$ 76	% Positive 75	% Positive 76	Max Conc 75	Max Conc 76
methoxychlor	0.91	0.74	5	5	89.9	15.42
oxychlordane	<0.01	nd	1	--	0.06	--
aldrin	0.33	0.08	3	8	34.4	2.32
chlordane	101	413.6	45	54	4979	11085
dieldrin	1.96	1.67	46	49	107	20.28
endrin	0.05	0.06	5	11	2.95	1.28
heptachlor	<0.01	nd	2	--	0.02	--
heptachlor epoxide	0.01	<0.01	4	5	0.67	0.05
toxaphene	0.2	nd	1	--	21.5	--
trans-chlordane	0.01	0.01	8	14	0.42	0.21
cis-chlordane	0.02	nd	4	--	1.41	--
lindane	<0.01	0.11	3	14	0.37	1.86
malathion	0.04	0.10	12	14	0.73	1.96
chlorpyrifos	0.43	0.03	10	11	15.01	0.66
diazinon	0.13	0.22	14	19	9.72	6.35
mirex		nd				--
parathion		nd				--
ronnel		<0.01		3		0.03
No. cpds	15	12				
lb/acre	105.1	416.6				

nd = no pesticides detected.

TABLE 17. COMPARISON OF TRANSFORMED MEAN SOIL GROUP I DATA BY PESTICIDE SHOP AND STORAGE AREAS VERSUS OTHER GROUP I AREAS FOR 13 INSTALLATIONS AND ALL INSTALLATIONS FOR CY 75 AND CY 76

	Shop and Storage		Non-Shop and Storage	
	CY 75	CY 76	CY 75	CY 76
13 Installations	3.11	3.48	0.71	0.54
All Installations	2.86	3.09	0.69	0.50
	lsd ($p<0.05$) = 0.67			

TABLE 18. CONTRAST OF 75/76 UNTRANSFORMED SOIL GROUP II DATA (ppm) (75 - 385 samples; 76 - 159 samples)

Pesticides	$\bar{x}$		% Positive		Max	
	75	76	75	76	75	76
methoxychlor	0.03	0.02	2	3	4.65	2.89
oxychlordane	<0.01	<0.01	3	3	0.1	0.07
aldrin	<0.01	<0.01	1	1	0.89	0.81
chlordane	0.81	0.23	22	14	49.12	7.20
dieldrin	0.22	0.43	28	32	19.63	25.95
endrin	<0.01	<0.01	1	5	0.13	0.25
heptachlor	<0.01	<0.01	1	<1	0.25	<0.01
heptachlor epoxide	0.02	<0.01	10	8	1.64	0.78
toxaphene	<0.01	0.01	1	<1	1.56	2.32
trans-chlordane	<0.01	0.01	1	16	0.45	0.20
cis-chlordane	0.01	<0.01	4	4	1.36	0.59
mirex	0.01	nd	1	--	0.05	nd
No. pesticides	12	11				
lb/acre*	1.16	0.76				

* Values of <0.01 treated as positive values (0.01) to determine totals.
nd = no pesticides detected.

TABLE 19. COMPARISON OF TRANSFORMED MEAN SOIL GROUP II DATA BY GOLF COURSES VERSUS OTHER SITES IN SOIL GROUP II FOR 13 INSTALLATIONS AND ALL INSTALLATIONS FOR CY 75 AND CY 76

	SOIL GROUPS			
	Golf Courses		Non-Golf Courses	
	CY 75	CY 76	CY 75	CY 76
13 Installations	1.09	0.88	0.58	0.62
All Installations	1.12	0.90	0.68	0.70
	lsd ($p<0.05$) = 0.27			

(d) Table 20 presents a comparison of transformed mean soil data (all soil Groups) for the 13 installations for CY 75 and CY 76. This table represents the difference between the CY 75 installation soil mean and the CY 76 installation soil mean. Any difference exceeding the ℓsd value of 0.54 ($p<0.05$) is significant. However, none of the differences observed between CY 75 and CY 76 for the 13 installations were significant, indicating that the observed differences were most likely the result of random sampling variation and not an indication of real trends or patterns.

(2) A comparison of pesticide residue data for CY 75 and CY 76 sediment is given in Table 21 utilizing untransformed data. This table shows consolidated residue data in addition to residue data for each of the four functional sediment sampling stratifications.

(a) A comparison of overall transformed mean pesticide residue data for sediment reveals no significant ℓsd difference when comparing the 33 installations from CY 75 with the 12 installations from CY 76 (CY 75 mean = 0.08, CY 76 mean = 0.08). However, a comparison (using transformed means) between the 12 installations for which there are sediment data for both CY 75 and CY 76 does reveal a significant ℓsd difference at the $p<0.05$ level (CY 75 mean = 0.12, CY 76 mean = 0.07). The overall decrease noted in CY 76 is probably the result of the very significant decrease shown in installation 17 from CY 75 to CY 76 (see Table 22). The only other significant differences noted in Table 22 are for installations 12 and 16. Both of these showed a significant increase in 1976.

(b) Evaluation of the specific sediment data for installation 17 shows there were five samples collected in CY 75, all of which were positive, and three samples from CY 76 only one of which was positive. This decrease is unexplainable.

(3) Table 23 is a comparison of CY 75 and CY 76 untransformed data in fish. Corresponding data for fish for CY 75 and CY 76 were available from only six installations. A comparison of transformed means for the 2 years shows no significant ℓsd difference (CY 75 = 0.67 and CY 76 = 0.74). The individual installation differences for CY 75 and CY 76, using transformed means, are presented in Table 24. Installation 12 shows a significantly higher mean for CY 76 than for CY 75 while all the other installations show no significant differences between the two years.

(4) A comparison of untransformed data for birds for CY 75 and CY 76 is given in Table 25. These data are too limited to provide any statistical comparisons. As stated in an earlier section of this report, only two CY 76 bird samples were analyzed for DDT residues. One of the two bird samples contained residues of p,p'-DDD in contrast to CY 75 where no residues of

TABLE 20. COMPARISON OF DIFFERENCES BETWEEN TRANSFORMED MEANS FOR SOIL, CY 75 VERSUS CY 76

Installation	YEAR CY 75	CY 76	Difference
10	0.38	0.48	0.10
11	0.42	0.76	0.34
12	1.22	1.25	0.03
13	0.49	0.38	0.11
14	0.39	0.31	0.08
15	0.12	0.10	0.02
16	0.75	1.21	0.46
17	1.62	1.82	0.20
18	0.69	0.38	0.31
19	1.33	1.20	0.13
20	0.52	0.46	0.06
21	0.76	0.69	0.07
22	0.92	1.11	0.19

lsd ($p<0.05$) = 0.54

TABLE 21. CONTRASTS OF PESTICIDE RESIDUES (ppm) IN 1975 vs 1976 SEDIMENT SAMPLES, UNTRANSFORMED DATA

	CONSOLIDATED				TRAVERSING															
					ENTRANCE				EXIT				ORIGINATING				IMPOUNDED			
	$\bar{x}$		Max		$\bar{x}$		Max		$\bar{x}$		Max		$\bar{x}$		Max		$\bar{x}$		Max	
	75	76	75	76	75	76	75	76	75	76	75	76	75	76	75	76	75	76	75	76
No. Samples	363	122	--	--	58	17	--	--	59	19	--	--	62	12	--	--	184	74	--	--
trans-chlordane	0.01	<0.01	0.30	0.02	<0.01	<0.01	0.12	0.01	<0.01	nd	0.01	--	nd	nd	nd	--	<0.01	<0.01	0.3	0.02
cis-chlordane	0.01	<0.01	2.53	0.02	<0.01	<0.01	0.05	0.01	<0.01	nd	0.1	--	<0.01	nd	0.01	--	0.01	<0.01	2.53	0.02
dieldrin	<0.01	<0.01	0.10	0.07	<0.01	nd	0.02	--	<0.01	nd	0.04	--	<0.01	nd	0.05	--	<0.01	<0.01	0.10	0.07
aldrin	0.01	<0.01	0.06	0.47	nd	nd	nd	--	<0.01	nd	0.01	--	<0.01	nd	0.01	--	<0.01	<0.01	0.06	0.47
chlordane	0.01	<0.01	1.62	0.12	0.01	nd	0.26	--	0.01	nd	0.14	--	<0.01	0.01	0.13	0.12	0.02	<0.01	1.62	0.01
oxychlordane	<0.01	nd	0.06	nd	nd	nd	nd	--	nd	nd	nd	nd	nd	nd	nd	nd	<0.01	nd	0.06	nd
Total conc	0.398	0.01			0.04	0.02			0.05	0			0.04	0.01			0.01	0.05		
No. pesticides	6	5			4	2			5	0			4	1			6	5		

nd = no pesticides detected.

TABLE 22. COMPARISON OF TRANSFORMED MEAN DIFFERENCES IN SEDIMENT FOR CY 75 AND CY 76

Installation	YEAR CY 75	CY 76	Difference
10	0.12	0	0.12
11	0.12	0	0.12
12	0.57	0.82	0.25*
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0.28	0.28*
17	1.34	0.35	0.99*
18	0	0.03	0.03
19	NS†	NS†	--
20	0.02	0.04	0.02
21	0	0	0
22	0.04	0.21	0.17
	lsd ($p<0.05$) = 0.20		

* Indicates significant CY 76 mean increase over CY 75.
† No samples collected.

TABLE 23. CONTRASTS OF PESTICIDE RESIDUES (ppm) in 1975 vs 1976 FISH SAMPLES, UNTRANSFORMED DATA

	$\bar{x}$		Max	
	75	76	75	76
No. Samples	108	35		
oxychlordane	<0.01	<0.01	0.06	0.05
chlordane	0.01	0.031	0.64	0.63
trans-chlordane	0.03	0.02	0.35	0.26
cis-chlordane	<0.01	<0.01	0.02	0.03
dieldrin	0.07	0.142	2.84	2.53
aldrin	<0.01	0.011	0.24	0.35
endrin	0.003	<0.01	0.11	0.11
heptachlor epoxide	<0.01	<0.01	0.08	0.08
toxaphene	0.02	0.013	1.52	0.46
β-BHC	nd	0.008	nd	0.27
α-BHC	<0.01	<0.01	<0.01	<0.01
mirex	<0.01	<0.01	0.17	0.03
diazinon	<0.01	0.005	0.02	0.17
heptachlor	<0.01	nd	0.02	nd
No. pesticides detected	13	13		

nd = no pesticides detected.

TABLE 24. COMPARISON OF TRANSFORMED MEAN DIFFERENCES IN FISH FOR CY 75 AND CY 76

Installation	YEAR CY 75	CY 76	Difference
10	0.22	0	0.22
11	0.58	0.65	0.07
12	1.67	2.44	0.77*
15	0.10	0.04	0.06
17	1.52	1.65	0.13
21	1.15	0.90	0.25

lsd ($p<0.05$) = 0.67

* Indicates significant CY 76 mean increase over CY 75.

TABLE 25. CONTRASTS OF PESTICIDE RESIDUES (ppm) in 1975 vs 1976 BIRD SAMPLES, UNTRANSFORMED DATA

	$\bar{x}$		Max	
	75	76	75	76
No. Samples	13	6		
oxychlordane	0.04	0.06	0.14	0.24
trans-chlordane	0.01	0.008	0.06	0.04
dieldrin	0.09	0.25	0.61	0.96
heptachlor epoxide	0.04	0.099	0.24	0.55
mirex	0.09	nd	0.64	--

nd = no pesticides detected.

p,p'-DDD were noted in 13 bird samples analyzed in that year. The finding of p,p'-DDD in CY 76 is more in line with the data of White[1] as part of the National Pesticide Monitoring Program. However, the complete absence of BHC and p,p'-DDT in the DAPMP bird samples for both CY 75 and CY 76 cannot be explained when contrasted to the data of White.

6. COMPARISONS WITH PUBLISHED PESTICIDE MONITORING DATA. The comparisons with published monitoring data presented in reference 2a represent the only significant data available. No more recent data have been published or made available in other forms that can be used for comparative purposes.

7. INTERIM ENVIRONMENTAL PESTICIDE CRITERIA. Interim environmental pesticide criteria established in reference 2a for evaluation of CY 75 DAPMP data were not applied to CY 76 data. The absence of DDT data for the majority of CY 76 samples precluded the comparable use of these criteria in evaluation of CY 76 environmental data.

8. CONCLUSIONS.

a. Untransformed data should not be relied upon in making statistical comparisons of environmental pesticide residues.

b. The stratified DAPMP sampling design is adequate to provide an environmental pesticide profile of an installation.

c. The significant differences noted in pesticide residue levels among the various soil land use stratifications for CY 75 were again very evident from evaluation of the CY 76 data.

d. In contrast to the 33 installation CY 75 data, no significant differences among the four functional sediment stratifications were noted with the 14 installation CY 76 data.

e. Fish, as indicators of pesticide contamination of the aquatic environment, exhibit a considerably greater diversity of pesticide residues than does sediment from the same body of water.

f. As in CY 75, the limited amount of bird data obtained for CY 76 allowed for only very limited statistical evaluations.

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[1] White, D. H., "Nationwide Residues of Organochlorines in Starlings," Pesticide Montrg J, 10(1):11-17 (1976).

g. The interactions among the various environmental components sampled are statistically significant with regard to definitive quantitative data. Qualitative data such as pesticide diversity and the frequency of occurrence require further statistical evaluation.

h. Comparison involving only 2 years data, i.e., CY 75 and CY 76, did not indicate any significant, general trends and patterns in pesticide residues.

i. A limited number of installations, i.e., a sample, is adequate to represent the total population of installations with regard to most sampling design characteristics.

j. Data derived from soil and sediment samples can provide a basic index of the spatial and temporal distribution of pesticides in the environment. In a serious constraint on available resources, these data can serve as a basis for tentative pesticide management decisions.

9. RECOMMENDATIONS.

a. Sample only soil and sediment from scheduled installations to provide confirmation of relationship among these components.

b. Increased emphasis be devoted to improving and expanding methodologies for:

(1) Chlorophenoxy herbicides.

(2) Carbamate pesticides.

(3) Relatively unstable organophosphorus pesticides.

(4) Sampling and extraction of air samples.

(5) Sampling, extraction and analysis of blood and urine for pesticides and their metabolites.

c. The distribution of individual installation reports be discontinued. Overall recommendations derived from evaluation and analysis of the CY 75-78 population sample data be forwarded to appropriate offices at MACOM HQ.

d. Pesticide usage data derived from DD Form 1532 should be consolidated and evaluated to provide actual pounds of pesticide used. This usage data could then be used to make statistical comparisons with environmental residue data.

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APPENDIX A

INSTALLATIONS SAMPLED BY MAJOR COMMANDS

FORSCOM

Fort Hunter-Liggett, CA
Fort Ord, CA
Fort McPherson, GA
Fort Polk, LA
Fort Devens, MA
Fort Bragg, NC
Fort Sam Houston, TX
Fort Lewis, WA

TRADOC

Fort Knox, KY
Fort Jackson, SC
Fort Leonard Wood, MO

DARCOM

Yuma Proving Ground, AZ
Rocky Mountain Arsenal, CO

USACC

Fort Huachuca, AZ

APPENDIX B

LISTING OF PESTICIDES/PESTICIDE METABOLITES ROUTINELY ANALYZED FOR IN CY 76 SAMPLES AND LOWER LIMITS OF DETECTABILITY FOR THESE PESTICIDES/PESTICIDE METABOLITES

Pesticides/Pesticide Metabolites	Limits of Detectability (ppm)* Soil and Sediment	Fish and Birds
α-BHC	0.003	0.002
β-BHC	0.010	0.005
aldrin	0.008	0.004
chlordane (tech)	0.060	0.030
cis-chlordane	0.008	0.004
trans-chlordane	0.008	0.004
oxychlordane	0.008	0.004
o,p'-DDD†	0.020	0.010
p,p'-DDD†	0.016	0.008
o,p'-DDE†	0.020	0.010
p,p'-DDE†	0.016	0.008
o,p'-DDT†	0.020	0.010
p,p'-DDT†	0.030	0.015
dieldrin	0.012	0.006
endrin	0.021	0.011
heptachlor	0.003	0.002
heptachlor epoxide	0.008	0.004
lindane	0.004	0.002
methoxychlor	0.080	0.040
mirex	0.010	0.010
toxaphene	0.800	0.400
chlorpyrifos	0.012	0.004 (FPD)
diazinon	0.052	0.0032 (FPD)
malathion	0.010 (FPD)	0.005 (FPD)
methyl parathion	0.030	0.003 (FPD)
parathion	0.020	0.0035 (FPD)
ronnel	0.010	0.004 (FPD)
PCB's (Aroclor 1248, 1254, 1260)†	0.400	0.020

* a. Limits of detectability are based on electron-capture detection, except where indicated as flame photometric detection (FPD).

b. Pesticides/pesticide metabolites not appearing on this listing are not presently being analyzed for; however, they may or may not have been present in a sample.

† DDT and its metabolites and PCB's were analyzed for in selected samples only.